M&R C510751-8-2

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SCIENCE APPLICATIONS, INC.

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COST ANALYSIS IN SUPPORT OF MINIMUM ENERGY STANDARDS FOR CLOTHES WASHERS AND DRYERS

DOE/CS/20329--T2

February 2, 1979

SCIENCE APPLICATIONS, INC.

ENERGY AND ENVIRONMENTAL SCIENCES DIVISION

COST ANALYSIS IN SUPPORT OF MINIMUM ENERGY STANDARDS FOR CLOTHES WASHERS AND DRYERS

Submitted to:

Office of Conservation & Solar Applications
Office of Buildings and Community Systems
Division of Energy Efficiency Applications
Consumer Products Efficiency Branch
20 Massachusetts Avenue, N.W.
Washington, D. C. 20461

Submitted by:

SCIENCE APPLICATIONS, INC.
Energy and Environmental Sciences Division
1651 Old Meadow Road, Suite 620
McLean, Virginia 22102

Contract No. ~~EM-78-C-03-1849~~ AC03-78CS20329
Study No. 1-029-03-151-04

COST ANALYSIS IN SUPPORT OF MINIMUM ENERGY STANDARDS FOR CLOTHES WASHERS AND DRYERS

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1. INTRODUCTION

This report presents the results of the cost analysis of energy conservation design options for laundry products. The analysis was conducted using two approaches. The first, presented in Section 2 below, is directed toward the development of industrial engineering cost estimates of each energy conservation option. This approach results in the estimation of manufacturers costs.

The second approach is directed toward determining the market price differential of energy conservation features. The results of this approach appear in Section 3 below. The market cost represents the cost to the consumer. It is the final cost, and therefore includes distribution costs as well as manufacturing costs.

Two comparison reports present the results of similar analyses conducted by SAI on comfort systems and kitchen appliances.

1.1 THE IMPORTANCE OF COST IN REGULATORY DECISION-MAKING

The regulatory decision process involves cost analysis and benefit analyses. The former includes an evaluation of the cost sustained by industry to comply with a regulation, the resulting cost to the consumer to acquire and use the goods or services provided by the regulated industry, and the overall impact of these costs on consumer/industry relationships. The benefit analysis examines the value of the regulation in terms of its principal objective (e.g., conservation of natural resources, preservation of the environment, or health/welfare of local, regional, or national populations).

Specifically, the establishment of national minimum energy efficiency standards for appliances must consider the total cost of these standards and the total benefits derived from their promulgation. Two of the major parts of the cost analysis are addressed in

this report. These are estimates of the initial cost to the appliance industry to incorporate design features which may result in reduced energy consumption and a preliminary comparative analysis of market prices to the consumer for products of varying efficiency or for products with and without features which are assumed to be energy efficiency related.

Section 5 of this report identifies several of the additional analyses which should also be accomplished to establish minimum energy efficiency standards for appliances.

1.2 THE ENGINEERING COST APPROACH AND THE MARKET PRICE APPROACH

The engineering cost estimates and market pricing analysis are intended to be mutually supportive. Each of the methodologies determine cost differently. In the engineering cost approach, costs are estimated on the basis of the production cost components; including labor, materials, capital, and development testing. The component costs are additive summing to the total cost of incorporating the energy saving option into each product.

The determination of market prices is intended to reflect the conditions of the market place. That is, demand considerations are included. Industry competition and marketing strategy are reflected in market prices, as well as manufacturing and distribution costs. In order to remain competitive it could be possible, at least in the short run, for manufacturing costs of energy saving features not to be passed through to the retail price. It could also be possible for retailers, for example, to exploit the popularization of energy conservation and the resulting stimulated demand with high charges for energy saving features. The market pricing methodology was carried out in order to capture these considerations.

1.3 OVERVIEW OF THE REPORT

The results of using both approaches are presented in this report. Section 2 presents the results of the industrial engineering cost estimates derived for all products. The cost components for each energy conservation feature are determined and the manufacturing costs estimated. In addition, estimates are made for R&D and capital requirements, which are prorated to the number of the units manufactured.

Section 3 presents the results of the market price analysis. Included are tables showing the price differential attributed to energy saving options. The market prices were collected from samples which are described in terms of geographic coverage, types of retail outlets, product models, and manufacturers.

The statistical techniques used to analyze the market price data are also described in Section 3. The basic purpose of this statistical analysis is to measure differences in market prices that can be associated with energy saving features.

A discussion of distribution costs also appears in Section 3. Included are estimates of transportation costs and retail mark-ups presented according to type of retail establishment considered.

Section 4 presents the results of selected comparisons between the estimates of option costs to the manufacturer and the market price increase for the same option or options.

Section 5 presents the conclusions and recommendations resulting from these cost analyses.

2. INDUSTRIAL ENGINEERING COST ESTIMATING

2.1 INTRODUCTION

This section describes the approach employed for, and presents the results obtained from, the industrial engineering cost analysis performed for this task. This analysis consists of the development of cost estimates resulting from the incorporation of each energy saving design option into each appliance covered in this project. These estimates are intended to reflect the incremental cost incurred by a typical manufacturer to design, fabricate or purchase, install, and test each option. Although these costs estimates include labor, materials, capital, development, and testing they do not cover possible incremental advertising and marketing costs. Further, no attempt is made to estimate the cost component which may be incurred to establish and verify continuous compliance with Federal energy standards after they have been promulgated. The results presented in this section are not production weighted and they do not pertain to a particular appliance manufacturer. They are, however, estimates of nominal incremental costs incurred by a typical manufacturer to incorporate a representative option into the appropriate appliance. These results are indicative of the relative order of magnitude and ranking of option costs to a typical product manufacturer.

2.2 APPROACH

The development of cost estimates at the manufacturer's level for each design option is accomplished by combining the existing data contained in SAI and National Bureau of Standards reports with information obtained from appliance parts distributors, appliance component suppliers, and subsystem manufacturers. This cost data base is augmented by information obtained from appliance distributors, contract sales operations, and manufacturers representatives. These

data are collated, evaluated, and modified to develop cost estimates for each energy saving design option. This process is outlined schematically on Figure 2-1.

The data base collected from parts distributors, component and subsystem manufacturers, and the SAI/NBS documents is primarily focused on the cost of design improvements associated with: (1) adding, improving, or increasing appliance seals and insulation; (2) reducing the energy consumed by appliance components or subsystems; and (3) modifying appliance operational characteristics by adding, deleting, or altering machine control functions. Cost estimates for the fourth generic class of energy saving option (i.e., appliance configuration modification) are developed by SAI based upon discussions with all of the above sources. Table 2-1 presents the specific options associated with each laundry product is addressed in this report.

Estimates of manufacturer's costs to incorporate each of the energy saving options listed on Table 2-1 are based upon varying levels of engineering analyses. Since most of these options exist in one or more products currently available in the retail market, a market pricing analysis is also conducted. This analysis is partially designed to develop option cost from option price. The price analysis is used to support the estimates resulting from the engineering approach. The market approach compares the price of products with energy saving options included in its design with the price of similar products which do not have energy saving features. The Market Pricing analysis is discussed in Section 3 of this report and the cost/price comparisons are made in Section 4.

2.3 SUMMARY OF RESULTS

The costs incurred by manufacturers to incorporate energy saving options include a labor component, a materials component, a capital component and a development test component. Although the majority of

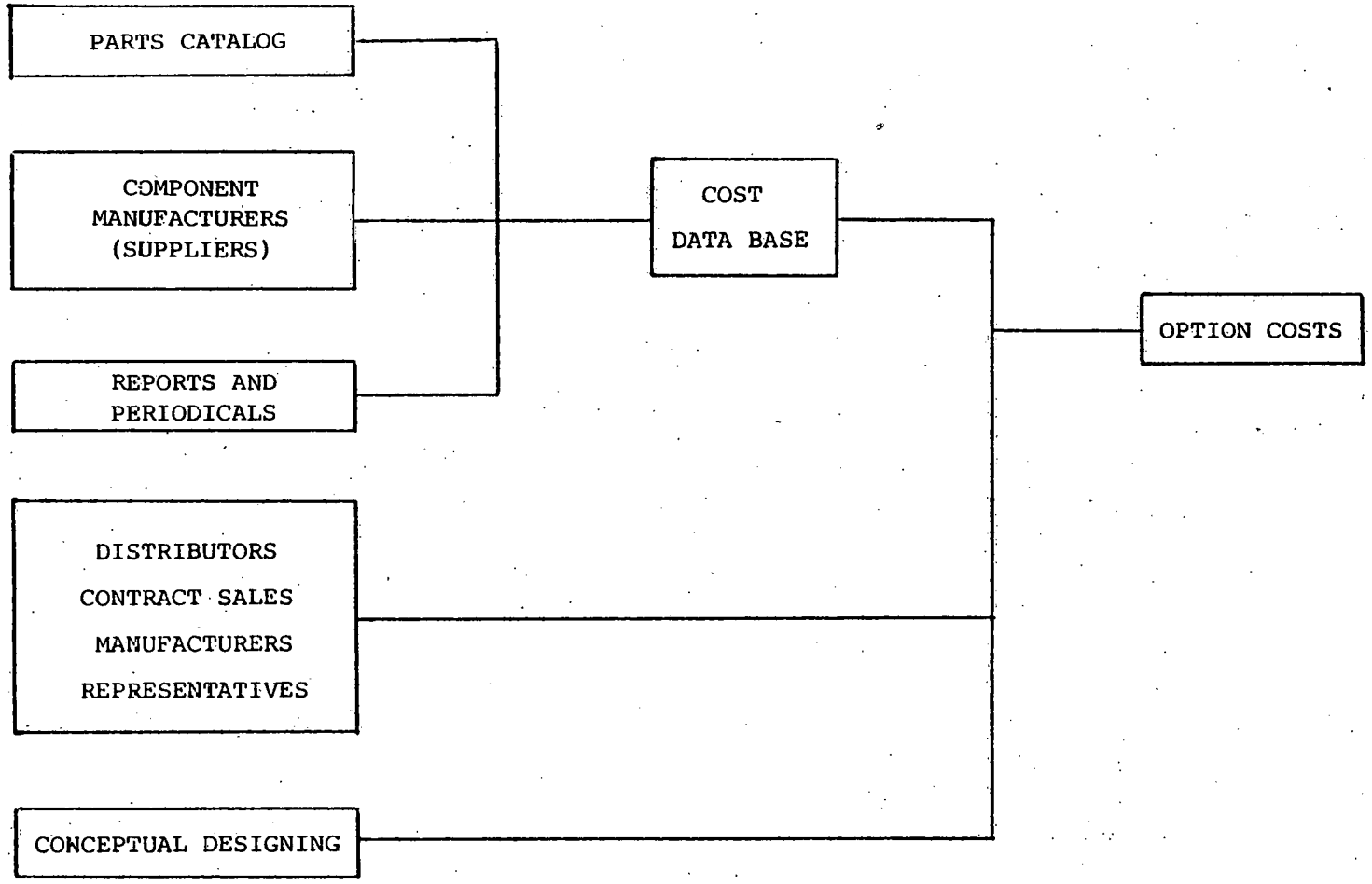


Figure 2-1. APPROACH

Table 2-1. ENERGY SAVING OPTIONS FOR LAUNDRY APPLIANCES

Product	Generic Option: Insulation/ Seals	Component Energy	Product Operations	Product Configurations
	Specific Option			
Clothes Washers	• Walls	• Motor	• Suds Saver • Mix Valve • Fill Control • Cold Rinse	• Tub Geometry • Front Loading • Thermal Mass
Clothes Dryers	• Walls/ Drum • Door	• Auto Ignition • Heating Element • Motor	• Dryness Sensor • Lint Filter	• Thermal Mass • Vent Losses • Air Preheat

the design options considered in this analysis exist in some products on the retail market, it is assumed that capital and development costs will be incurred to incorporate them in more products, or perhaps all products, produced by a typical manufacturer. For example, if one class of product produced by a manufacturer already contains one or more of the subject options, that manufacturer will still incur additional capital investment, development, testing, and evaluation costs to incorporate these same options in another class of products. Further some manufacturers may not possess the equipment, facilities, or experience needed to incorporate an option. On the other hand, some manufacturers may have excess capability and adequate experience and therefore would incur only the incremental labor and materials components. In the absence of comprehensive data regarding each manufacturers' production capability and product characteristics, it is assumed that the estimated costs associated with each energy saving design option is experienced by all manufacturers. Further, it is assumed that each product containing an option is assigned the same incremental cost. In summary, the incremental cost estimates for each option are incurred by all products manufactured with that option. No attempt has been made to differentiate between manufacturers or to adjust these data for production quantity.

The data displayed in Table 2-2 summarizes the engineering cost estimates for laundry appliances. This data includes estimates for incremental labor, materials, capital, and development/test/evaluation for each combination of product and design option. The details of the calculations and descriptive information regarding each option are contained in subsequent sections of this report.

2.4 DESCRIPTION OF THE ENGINEERING COST DATA BASE

2.4.1 Reports and Periodicals

The cost data base used to develop the incremental cost estimates summarized in the preceding section consists of three principal sources.

Table 2-2 ESTIMATED TOTAL INCREMENTAL COST OF ENERGY SAVING DESIGN OPTIONS FOR LAUNDRY APPLIANCES

Appliance	Energy Saving Design Option	Incremental Cost (1978$)
Clothes Washer	Eliminate Warm Rinse	.12
	Reduce Hot Water Flow	.40
	Thermostatic Mix Valve	10.59
	Reduce Clearance Between Tubes	6.20
	Recycle Wash Water	9.46
	Improve Fill Control	5.36
	Increase Motor Efficiency	7.98
	Add Insulation	6.34
	Front Loading Configuration	21.15
	Reduce Thermal Mass	1.02
Clothes Dryer	Auto Ignition	8.47
	Add Insulation	5.66
	Improve Heating Element	5.12
	Preheat Incoming Air	14.79
	Improve Dryness Sensor	7.21
	Improve Door Seals	.67
	Increase Motor Efficiency	10.36
	Improve Lint Filter	2.72
	Reduce Thermal Mass	1.04
	Reduce Vent Losses	14.79

The first of these is reports and periodicals. The principal reports used herein are those covering the SAI and NBS work performed for the energy targets program. These efforts addressed several energy saving design options for laundry appliances and contain both option cost estimates and calculations of potential energy savings resulting from each option. The output of these efforts is summarized for each product in Table 2-3. The incremental manufacturers' costs, shown on Table 2-3, are essentially in terms of 1977 dollars.

Although the development of these tables requires some interpretation of the original information, the data displayed is a valuable module of the cost data base for the current study.

Several periodicals are also employed as part of the data base for the engineering cost estimating technique. *Appliance Manufacturer, Consumer Digest, Consumer Reports, Consumers' Research,* and *Merchandising Magazine* provide data and information relevant to option availability, acceptance, and design. Further, some articles found in these publications produced indications of the incremental costs resulting from the incorporation of certain options. Other articles contain data useful for the development of capital investment and test/evaluation cost estimates associated with several options. Table 2-4 presents one of the data displays available from these periodicals used in the industrial engineering cost estimating process.

In addition to the above mentioned documents, other reports are employed to augment the cost data base. These include portions of the testimony given during the targets program hearings, several products of the Oak Ridge National Laboratory, and a report by A. D. Little, Inc.

2.4.2 Appliance Parts Catalogs

The second principal source of cost data used in this analysis is found in parts catalogs provided by appliance parts distributors.

Table 2-3. SUMMARY OF NBS AND SAI LAUNDRY APPLIANCE OPTION COSTS AND ENERGY SAVINGS FOR TARGETS PROGRAM

Product	Energy Saving Option	Estimated Manufacturer's Cost ($)* NBS	Estimated Manufacturer's Cost ($)* SAI	Estimated Energy Savings (%)* NBS	Estimated Efficiency Increase (%)* SAI
Clothes Washer	Eliminate Warm Rinse	.33	(.35)	25	29
	Reduce Hot Water	.33	-	8	-
	Thermo Mix Valve	5.50	-	12	-
	Reduce Tub Clearance	5.63	-	5	-
	Recycle Wash Water	6.67	16.07	10	-
	Improve Fill Control	-	-	-	-
	Increase Motor Efficiency	-	5.67	-	0
	Add Insulation	-	-	-	0
	Front Loading	-	-	-	-
	Reduce Thermal Mass	-	-	-	-
Clothes Dryer	Auto Ignition	4.00	0	40	26
	Add Insulation	1.50	2.00	5	7
	Improve Heater	0	1.67	2	2
	Preheat Air	-	-	-	-
	Improve Sensor	-	-	-	-
	Improve Seals	-	.58	-	-
	Increase Motor Efficiency	-	3.67	-	0
	Improve Lint Filter	-	1.97	-	-
	Reduce Thermal Mass	-	-	-	-
	Reduce Vent Losses	-	-	-	-

*Maximum Values

Table 2-4. PRODUCT PRODUCTION DATA — 1977

Product	Product Class	Number Shipped (M)	Approximate Number of Manufacturers	Average Number Shipped Per Manufacturer (K)
Clothes Washers	Automatic & Semi-Automatic	4.9	12	408
Clothes Dryers	Gas	0.7	12	58
	Electric	2.8		233

These documents contain price and performance information for the majority of the product components of interest in this study. For example, these catalogs contain motor data, heating element data, value data, timer data, gasket data, filter data, and compressor data up to three-ton size machines. These documents also contain information on brackets, supports, and hardware needed to mount, install, and interchange many of the components under consideration. Although the information available in these catalogs are not fully exploited for this study, the existence and availability of this data served to augment and verify cost estimates and calculations derived from other sources.

2.4.3 Suppliers and Distributors

The third principal source of cost data for energy saving design options is suppliers and distributors. Estimates of incremental costs to incorporate specific options are made by these organizations or data provided by them is used to calculate estimated costs. Table 2-5 lists the suppliers that comprise this data base.

A few distributors also provided information regarding the price of certain products which contained or did not contain specific options. Although this data is not directly related to manufacturers costs it is relevant information which can be reduced to the manufacturers level.

Since the majority of the data collected from suppliers is associated with several of the products covered by this report, specific information obtained from this source is presented in the discussion of results. It should be noted, however, that all of these data represent first approximations of engineering costs and do not reflect the results of detailed engineering design studies and cost estimates which can only be accomplished by the major appliance manufacturers.

Table 2-5. SUPPLIERS WHICH COMPRISE OPTION COST DATA BASE

Bentley Harris Mfg. Co.	Lionville, PA
Bristol Saybrook Co.	Old Saybrook, PA
Carborundum	Niagara Falls, NY
Eaton Control Products	Carol Stream, IL
Electro Therm, Inc.	Laurel, MD
Elmwood Sensors	Cranston, RI
Essex Group	Loganport, IN
Fenwal, Inc.	Ashland, MA
Franklin Electric	Bluffton, IN
Hercules, Inc.	Wilmington, DE
Johns Manville	Denver, CO
LAU Industries	Dayton, OH
Mallory Timers Co.	Indianapolis, IN
Robertshaw Controls Co.	Richmond, VA
Singer Company	Schiller Park, IL
Sundstrand	Dowagiac, MI
Teccor Electronics	Euless, TX
Tecumseh Products Co.	Tecumseh, MI
Teledyne Still-Man Mfg.	Cookeville, TN
Therm-O-Disc, Inc.	Mansfield, OH
Universal Electric Co.	Owosso, MI

2.5 ENGINEERING COST ESTIMATING TECHNIQUES

The three principal sources discussed in the preceding paragraphs provide essentially all of the estimates for material costs of options for each product. The total cost of each option, however, must also consider additional labor, capital, and development costs.

U. S. Department of Labor statistics (September 1978) indicate that the average hourly earnings for production or nonsupervisory workers in household appliances is $5.78. Further, household laundry workers receive $6.84 per hour. The latter value ($6.84) is used for all labor estimates in this analysis, Actual labor costs for each option are developed including a labor overhead rate of 100 percent or a total labor cost to the manufacturer of $13.68 per additional man-hour required to incorporate energy saving design options (in 1978 dollars).

Estimates for incremental capital expenditures, resulting from design options, are based upon several factors. Capital costs are first estimated for one manufacturer and for one particular option. These estimates are then expanded by the number of manufacturers that produce the product of interest. The resulting cost is then recovered over a three or five year period at a 10 percent annual capital recovery rate and prorated over the number of appliances produced during the recovery period. The annual production rates for each product displayed in Table 2-4 are assumed to be constant over the three or five year recovery period. Capital expenditure estimates less than one million dollars per manufacturer for specialized machinery and equipment are recovered over a three year period. Expenditures of one million or more dollars are recovered over a five year period. Table 2-6 identifies the principal types of equipment associated with the manufacturing of appliances and the incorporation of design options. The estimates of capital cost used in this report reflect the purchase or modification of these machines. Although the estimates

reflect a rational level of incremental investment for an appliance manufacturer and a specific option, they are not the result of extensive production engineering analyses designed to select and price specific capital equipment for purchase or modification.

Table 2-6. PRINCIPAL MANUFACTURING EQUIPMENT AND OPERATIONS

Equipment	Operation
Presses	Cutting, Forming, Squeezing, Drawing
Dies	Blanking, Bending, Cupping, Progressive
Metal Joining	Pressure Welding, Fusion Welding, Soldering, Brazing
Foundry	Molding, Casting, Heat Treating
Materials Handling	Material Handling
Machine Tools	Material Shaping

The incremental cost of developing and testing a given product containing a design option is based upon available data on the testing of refrigerator-freezers. These data indicate that the average cost per test is $1500. This cost is increased by an amount equal to the manufacturers cost to produce one test product. One test product is assumed to cost three times more than a production product to account for introducing energy saving design options, special handling, and instrumentation requirements. It is also assumed that one test product is required for every three tests performed.

The cost per test is prorated over the average number of products produced by each manufacturer to determine the cost/test/product. The number of tests needed to satisfy product performance, safety, and reliability criteria is based upon each option. The prorated incremental development and testing cost for a given design option is the product of the cost per test per product and the number of required tests.

The actual incremental costs developed from the above estimating techniques are presented in the discussion of results in the next section.

2.6 DISCUSSION OF RESULTS

2.6.1 General

The quantity of materials and components contained in some of the products addressed in this study is summarized in Table 2-7. Although total cost estimates for the labor and materials to produce the 8.5 million washers and dryers shipped in 1977 are not available the total value shipped was $2.8 billion dollars. The calculations described in this section indicate that the incremental cost of the energy saving options range from approximately one to $20 per unit. These cost increases would result in a minimum increase in the value shipped of from 0.3 to 6 percent.

The cost estimates developed for the products and energy saving design options covered in this analysis are in 1978 dollars. They are estimates of incremental costs to the product manufacturers and do not include profit, advertising, and distribution.

The incremental cost of some of the options considered are essentially independent of product class. The incremental cost of these options is a constant for all classes of product manufactured. Other options result in an incremental cost which varies with product class. The cost of this type of option is dependent upon the class of product under consideration. Figure 2-2 displays these two concepts for option costs in graphic form.

2.7 RESULTS OF THE ENGINEERING COST ANALYSIS OF LAUNDRY PRODUCTS

The results of the engineering cost estimating calculations for clothes washers and clothes dryers are presented in this section.

Table 2-7. QUANTITY OF MATERIALS AND COMPONENTS IN LAUNDRY APPLIANCES

Materials and Components	Clothes Dryers	Clothes Washers
Aluminum (tons)	900	22,455
Plastics (tons)	1,799	27,445
Steel (tons)	228,798	271,955
Gasketing (tons)	1,976	4,242
Connectors, elec.	78,390,000	82,335,000
Cord, elec. (Miles)	3,955	5,200
Motors	3,598,000	4,990,000
Switches	10,794,000	22,455,000
Thermostats	7,904,000	-
Timers	3,598,000	4,990,000
Wire, elec. (miles)	41,284	82,694
Knobs/Dials	3,598,000	9,980,000
Labels/Nameplates	19,406,000	17,465,000
Fasteners	560,940,000	923,150,000
Paint (gallons)	1,799,000	2,495,000
Porcelain Enamel (square miles)	3.96	10.98
Corrugated Fiberboard (square miles)	5.76	18.51

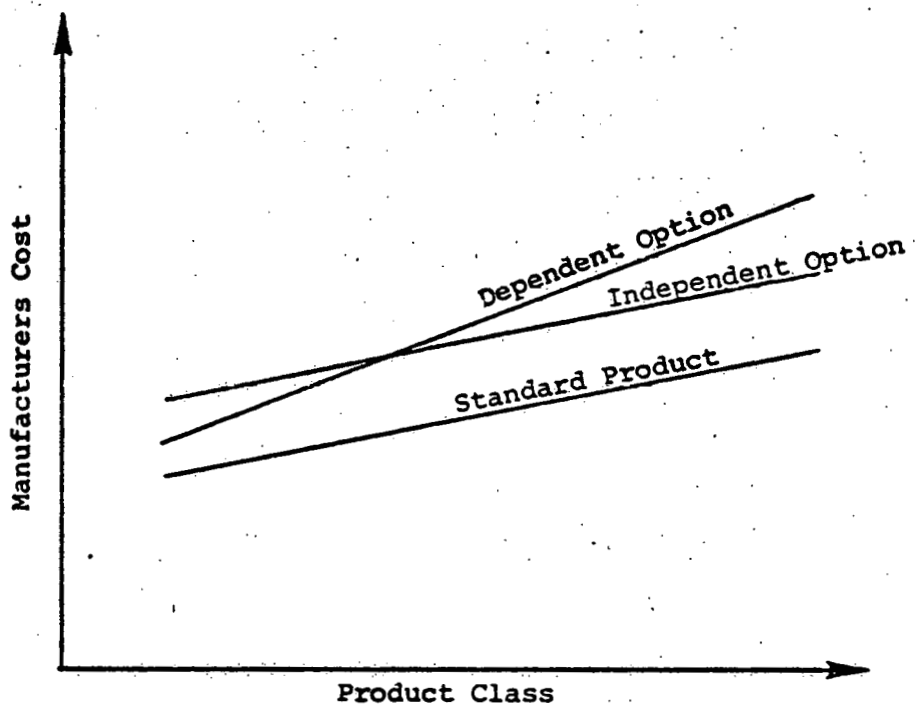


Figure 2-2. DEPENDENCY OF OPTION COST ON PRODUCT CLASS

Incremental costs associated with ten design options for each of these products are presented. A brief description of each is also included.

2.7.1 Clothes Washers

Estimates of manufacturers' costs to incorporate energy saving options in the design of clothes washers are presented here. The options considered for this product are described below:

- Warm Rinse — This option considers the elimination of the warm rinse from washer design. It consists of modifying or eliminating the selector switch controlling rinse water temperature.

- Reduce Hot Water Flow — This option consists of modification of the water inlet solenoid valve to reduce the flow of hot water into the washer tub during warm wash and rinse operations.

- Thermostatic Mix Valve — This option addresses the replacement of the current mix valve with one which controls the mix of hot and cold water (i.e., the temperature of warm water) thermostatically. This valve will automatically control water flow rate as a function of hot or cold water inlet temperature and the desired temperature of the warm water setting.

- Radial Tub Clearance — This option consist of an inner or outer tub redesign to reduce the clearances between the inner tub and the outer tub. This redesign will serve to reduce the energy lost in the water normally trapped in this wasted space.

- Recycle Wash Water — This option covers a substantial redesign of automatic clothes washers to discharge and re-use wash water. It consists of plumbing modifications to transfer used water to and from an external tub for re-use during the wash cycle.

- Improved Fill Controls — This option includes improvements in fill timer quality and pressure backup system to control the amount of water used during each machine cycle.

- Improve Motor — This option covers the use of split capacitor motors in all machines. It also considers the use of ball bearings instead of sleeve bearings in all motors.

- Insulation — This option involves the use of high density thermal insulation on the interior of the washer.

- Front Loading — This option assumes that clothes agitating top loading machines will be replaced by clothes tumbling, front loading machines.

- Thermal Mass Reduction — This option considers the reduction of washer tub mass to reduce the amount of thermal energy involved in tub metal heating.

The major assumptions involved in the development of incremental costs to incorporate the above options into the design of clothes washers are as follows:

- An hourly labor ate of $6.84.
- Materials cost derived from the cost data base
- Capital investment ranging from approximately $10K to $75K per manufacturer depending upon the option considered
- Development costs based upon $1,622 per test per manufacturer including labor, materials, and overhead. The number of tests required is a function of the option under evaluation.

The results of these cost calculations for a typical manufacturer are summarized in Tables 2-8a. through 2-8j. These data are in terms of 1978 dollars.

2.7.2 Clothes Dryers

Estimates of manufacturers costs to incorporate energy saving design options for clothes dryers are covered in this section. The options considered for both gas and electric machines are discussed below:

Table 2-8a. COST COMPONENTS OF A DESIGN OPTION

Product: CW Class: All Design Option: Eliminate Warm Rinse

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0	Hours	$ 0
2.	Direct Materials	0	$ per Unit		Per Unit	$ 0
3.	Investment	0	$ per Option		Per Unit	$ 0
4.	R&D	49K	$ per Option		Per Unit	$ 0.12
	Total Direct Costs					$ 0.12
5.	Overhead	Average of Industry Rate			Per Unit	$ 0
	Total Manufacturing Cost					$ 0.12

Table 2-8b. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Reduces Hot Water

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0	Hours	$ 0
2.	Direct Materials	0.33*	$ per Unit		Per Unit	$ 0.33
3.	Investment	0	$ per Option		Per Unit	$ 0
4.	R&D	28.6K	$ per Option		Per Unit	$ 0.07
	Total Direct Costs					$ 0.40
5.	Overhead	Average of Industry Rate			Per Unit	$ 0
	Total Manufacturing Cost					$ 0.40

*Average of two data points from one report and one parts catalog.

Table 2-8c. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Thermostatic Valve

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	7.02*	$ per Unit		Per Unit	$ 7.02
3.	Investment	40K	$ per Option		Per Unit	$ 0.04
4.	R&D	44.9K	$ per Option		Per Unit	$ 0.11
	Total Direct Costs					$ 8.88
5.	Overhead	Average of Industry Rate			Per Unit	$ 1.71
	Total Manufacturing Cost					$ 10.59

*Average of six data points in one report.

Table 2-8d. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Radial Tub Clearance

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	____	Hours	$ 1.38
2.	Direct Materials	0	$ per Unit		Per Unit	$ 0
3.	Investment	750K	$ per Option		Per Unit	$ 0.74
4.	R&D	1100K*	$ per Option		Per Unit	$ 2.70
	Total Direct Costs					$ 4.82
5.	Overhead	Average of Industry Rate			Per Unit	$ 1.38
	Total Manufacturing Cost					$ 6.20

*Developed from data in one report.

Table 2-8e. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Water Recycle

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	5.70*	$ per Unit		Per Unit	$ 5.70
3.	Investment	120K	$ per Option		Per Unit	$ 0.12
4.	R&D	90K	$ per Option		Per Unit	$ 0.22
			Total Direct Costs			$ 7.75
5.	Overhead		Average of Industry Rate		Per Unit	$ 1.71
			Total Manufacturing Cost			$ 9.46

*Average of four data points from one periodical and two reports.

Table 2-8f. COST COMPONENTS OF A DESIGN OPTION

Product: CW Class: All Design Option: Fill Control

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.12	Hours	$ 0.86
2.	Direct Materials	3.45*	$ per Unit		Per Unit	$ 3.45
3.	Investment	80K	$ per Option		Per Unit	$ 0.08
4.	R&D	44.9K	$ per Option		Per Unit	$ 0.11
	Total Direct Costs					$ 4.50
5.	Overhead	Average of Industry Rate			Per Unit	$ 0.86
	Total Manufacturing Cost					$ 5.36

*Developed from catalog data.

Table 2-8g. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Motor

	COMPONENT		COST PRICE	QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.06	Hours	$ 0.43
2.	Direct Materials	7.00*	$ per Unit		Per Unit	$ 7.00
3.	Investment	8K	$ per Option		Per Unit	$ 0.01
4.	R&D	44.9K	$ per Option		Per Unit	$ 0.11
			Total Direct Costs			$ 7.55
5.	Overhead		Average of Industry Rate		Per Unit	$ 0.43
			Total Manufacturing Cost			$ 7.98

*Developed from supplier data and one report 1/3 - 1/2 HP PSC motors.

Table 2-8h. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Insulation

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	2.77*	$ per Unit		Per Unit	$ 2.77
3.	Investment	40K	$ per Option		Per Unit	$ 0.04
4.	R&D	44.9K	$ per Option		Per Unit	$ 0.11
			Total Direct Costs			$ 4.63
5.	Overhead		Average of Industry Rate		Per Unit	$ 1.71
			Total Manufacturing Cost			$ 6.34

*Calculated from supplier data.

Table 2-8i. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Front Loading

	COMPONENT	COST PRICE		QUANTITY	OPTION COST
1.	Direct Labor	6.84	$ per hr.	0 Hours	$ 0
2.	Direct Materials	20.44*	$ per Unit	Per Unit	$ 20.44
3.	Investment	500K	$ per Option	Per Unit	$ 0.49
4.	R&D	90K	$ per Option	Per Unit	$ 0.22
	Total Direct Costs				$ 21.15
5.	Overhead	Average of Industry Rate		Per Unit	$ 0
	Total Manufacturing Cost				$ 21.15

*Developed from periodical data.

Table 2-8j. COST COMPONENTS OF A DESIGN OPTION

Product: CW **Class:** All **Design Option:** Thermal Mass

	COMPONENT		COST PRICE	QUANTITY	OPTION COST
1.	Direct Labor	6.84	$ per hr.	0 Hours	$ 0
2.	Direct Materials	0	$ per Unit	Per Unit	$ 0
3.	Investment	400K	$ per Option	Per Unit	$ 0.41
4.	R&D	249K	$ per Option	Per Unit	$ 0.61
			Total Direct Costs		$ 1.02
5.	Overhead		Average of Industry Rate	Per Unit	$ 0
			Total Manufacturing Cost		$ 1.02

- Automatic Ignition — This option covers the replacement of all standing pilot lights in gas dryers with glow bar or spark ignitors. It should be noted that most dryers currently contain glow bar type ignition systems.

- Insulation — This option considers the use of high density fiberglass insulation on the inside surface of the dryer cabinet.

- Improved Electric Heater — This option involves the installation of a more efficient multi-coil heating element in electric dryers.

- Air Preheater — This option assumes the use of a vent heat exchanger to preheat the air used for load drying.

- Dryness Sensors — This option considers the use of moisture sensors and precision thermostats to reduce the amount of overdrying normally experienced with standard dryers.

- Door Seals — This option involves improved dryer seals to reduce hot air and cold air exchange during the drying cycle.

- Improved Motor — This option covers the substitution of ball bearing split capacitor motors for sleeve bearing and shaded pole motors in all machines.

- Improved Lint Filter — This option covers increasing the area of the dryer lint filter. Increase area will reduce the pressure drop across the filter for a given quantity of lint allowing for improved air flow during drying process.

- Reduced Thermal Mass — This option involves a reduction in dryer drum mass to reduce the heat loss in drum metal heating.

- Reduced Vent Losses — This option is described in the same manner as air preheating above.

The assumptions made to develop incremental engineering cost estimates for each of these options are itemized below:

- An hourly labor rate of $6.84.

- Materials costs extracted from the cost data base.

- Capital investment as a function of design option ranging from approximately $10K to $1.5M for each dryer manufacturer.

- Development cost of approximately $1,600 per test per manufacturer including labor, material, and overhead. Cost per test of gas dryers $1,601 and is $1,592 for electric machines.

Estimates of incremental cost per option for clothes dryers are presented in Tables 2-9a through 2-9j. These values are presented in 1978 dollars and represent the costs incurred for a typical manufacturer.

Table 2-9a. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** Gas **Design Option:** Auto Ignition

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	3.75*	$ per Unit		Per Unit	$ 3.75
3.	Investment	80K	$ per Option		Per Unit	$ 0.57
4.	R&D	42.6K	$ per Option		Per Unit	$ 0.73
	Total Direct Costs					$ 6.76
5.	Overhead	Average of Industry Rate			Per Unit	$ 1.71
	Total Manufacturing Cost					$ 8.47

*Developed from catalog data and data in one report.

Table 2-9b. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Insulation

	COMPONENT		COST PRICE		QUANTITY	OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	2.09*	$ per Unit		Per Unit	$ 2.09
3.	Investment	40K	$ per Option		Per Unit	$ 0.06
4.	R&D	26K	$ per Option		Per Unit	$ 0.09
	Total Direct Costs					$ 3.95
5.	Overhead	Average of Industry Rate			Per Unit	$ 1.71
	Total Manufacturing Cost					$ 5.66

Calculated from supplier data and data from two reports.

Table 2-9c. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** Elect. **Design Option:** Heater

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.12	Hours	$ 0.86
2.	Direct Materials	3.26*	$ per Unit		Per Unit	$ 3.26
3.	Investment	8K	$ per Option		Per Unit	$ 0.01
4.	R&D	30K	$ per Option		Per Unit	$ 0.13
	Total Direct Costs					$ 4.26
5.	Overhead Average of Industry Rate				Per Unit	$ 0.86
	Total Manufacturing Cost					$ 5.12

*Developed from catalog data.

Table 2-9d. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Air Preheat

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	9.98*	$ per Unit		Per Unit	$ 9.98
3.	Investment	1150K	$ per Option		Per Unit	$ 1.03
4.	R&D	105K	$ per Option		Per Unit	$ 0.36
	Total Direct Costs					$ 13.08
5.	Overhead	Average of Industry Rate	Per Unit			$ 1.71
	Total Manufacturing Cost					$ 14.79

*Estimated from catalog data.

Table 2-9e. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Dryness Sensor

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.12	Hours	$ 0.86
2.	Direct Materials	5.24*	$ per Unit		Per Unit	$ 5.24
3.	Investment	80K	$ per Option		Per Unit	$ 0.11
4.	R&D	41K	$ per Option		Per Unit	$ 0.14
	Total Direct Costs					$ 6.35
5.	Overhead	Average of Industry Rate			Per Unit	$ 0.86
	Total Manufacturing Cost					$ 7.21

*Developed from catalog and supplier data.

Table 2-9f. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Door Seals

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0	Hours	$ 0
2.	Direct Materials	0.58*	$ per Unit		Per Unit	$ 0.58
3.	Investment	0	$ per Option		Per Unit	$ 0
4.	R&D	26K	$ per Option		Per Unit	$ 0.09
	Total Direct Costs					$ 0.67
5.	Overhead	Average of Industry Rate			Per Unit	$ 0
	Total Manufacturing Cost					$ 0.67

*Average of two data points from one catalog and one report.

Table 2-9g. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Motor

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.06	Hours	$ 0.43
2.	Direct Materials	9.35*	$ per Unit		Per Unit	$ 9.35
3.	Investment	8K	$ per Option		Per Unit	$ 0.01
4.	R&D	41K	$ per Option		Per Unit	$ 0.14
	Total Direct Costs					$ 9.93
5.	Overhead	Average of Industry Rate			Per Unit	$ 0.43
	Total Manufacturing Cost					$ 10.36

*Developed from catalog data - 1/3 HP PSC motor.

Table 2-8h. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Lint Filter

	COMPONENT	COST PRICE		QUANTITY	OPTION COST
1.	Direct Labor	6.84	$ per hr.	0 Hours	$ 0
2.	Direct Materials	2.60*	$ per Unit	Per Unit	$ 2.60
3.	Investment	20K	$ per Option	Per Unit	$ 0.03
4.	R&D	26K	$ per Option	Per Unit	$ 0.09
	Total Direct Costs				$ 2.72
5.	Overhead	Average of Industry Rate	Per Unit		$ 0
	Total Manufacturing Cost				$ 2.72

*Average of two data points from one catalog and one report.

Table 2-9i. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Thermal Mass

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0	Hours	$ 0
2.	Direct Materials	0	$ per Unit		Per Unit	$ 0
3.	Investment	600K*	$ per Option		Per Unit	$ 0.86
4.	R&D	52.5K	$ per Option		Per Unit	$ 0.18
	Total Direct Costs					$ 1.04
5.	Overhead	Average of Industry Rate			Per Unit	$ 0
	Total Manufacturing Cost					$ 1.04

*Estimated from supplier information.

Table 2-9j. COST COMPONENTS OF A DESIGN OPTION

Product: CD **Class:** All **Design Option:** Vent Losses

	COMPONENT	COST PRICE		QUANTITY		OPTION COST
1.	Direct Labor	6.84	$ per hr.	0.25	Hours	$ 1.71
2.	Direct Materials	9.98*	$ per Unit		Per Unit	$ 9.98
3.	Investment	1150K	$ per Option		Per Unit	$ 1.03
4.	R&D	105K	$ per Option		Per Unit	$ 0.36
	Total Direct Costs					$ 13.08
5.	Overhead	Average of Industry Rate			Per Unit	$ 1.71
	Total Manufacturing Cost					$ 14.79

*Estimated from catalog data.

3. MARKET PRICING

3.1 INTRODUCTION

The results of the market price analysis are presented in this section of the report. The overall objective of the market price analysis is to identify and measure the cost to the consumer of purchasing energy saving options that have been incorporated into laundry appliances. The consumer is concerned with the problem of whether or not the added cost of acquiring energy saving features is justified, considering the savings in energy costs that would result. This part of the project seeks to determine the incremental market prices attributable to including laundry appliance energy savings features. Whereas Section 2 addressed the manufacturing cost of producing energy saving features, this section addresses the cost of acquiring such features by the consumer.

The research conducted on market pricing involved three phases. The first phase consists of the development of the sample to include representative appliance models, national coverage and representative types of retail establishments. The second phase is concerned with the actual collection of market price data. This phase consists of collecting retail prices for the selected appliance models, at the selected locations and types of retail outlets. The third and final phase consists of processing and analyzing the data collected to measure price differentials associated with energy saving features.

3.2 THE RELATIONSHIP OF MARKET PRICING TO ENGINEERING COSTING

Market price is relatable to engineering costs. Comparisons can be made between the market price and the manufacturing cost, accounting for profits and distribution costs. The manufacturing cost plus distribution cost and profit should equal the retail price. If manufacturing costs plus distribution costs are more than the

retail price, it may indicate that the increased costs incurred for incorporating energy saving features cannot be passed on to consumers. That is- consumers do not perceive that the higher product price would be justified in terms of expected reductions in energy costs.

On the other hand, if retail prices for energy savings features are higher than the costs involved, it may mean that retailers and manufacturers are finding the sales of energy saving features profitable. A comparison of market prices and manufacturing costs appears in Section 4 of this report.

3.3 SUMMARY OF RESULTS

The objective of the analysis of market prices is to measure how market prices vary with the incorporation of energy saving features. The energy saving features for kitchen appliances that could be identified and measured separately in the market price analysis are as follows:

- Clothes washers
  - Improved fill control
  - Front loading configuration
  - Recycle wash water
- Clothes dryer
  - Automatic moisture sensor

The incremental market prices of the energy saving features appear in Table 3-1.

Table 3-1. HOUSEHOLD LAUNDRY EQUIPMENT

Appliance	Energy Saving Feature	Incremental Market Price
Clothes Washer	• Improved fill control	$ 22.00
	• Front loading configuration	16.95
	• Recycle wash water	33.00
Clothes Dryer	• Automatic moisture sensor	29.14

3.4 SAMPLE OF APPLIANCE MODELS

The initial data base for laundry appliances was derived from manufacturers' catalogues provided by AHAM. These catalogues were the most current ones available, and in most cases were 1977 catalogues, although 1978 editions were used for some appliances. This difference in model years created some difficulties in the subsequent market pricing because of model number changes. Consumer-oriented reports and publications were also used to augment the manufacturers' literature. Although most of these publications did not cover as wide a range of models as was needed for this study, they did provide some useful technical data and laboratory test results that were not available in the manufacturers' catalogues. Although many of the appliance models described in the consumer publications were obsolete, comparable current models were listed in the manufacturers' brochures.

The manufacturers elected for use in the data base were major manufacturers that manufacture and market appliances under their own name. Such brand names as Sears, Penneys, and Wards were excluded.

Additional criteria for selecting the manufacturers used for the market pricing data base include: nationwide availability, market sector leaders, size of model line, and manufacturers who produce more than one of the appliance types under consideration. The rationale for using these selection criteria was essentially to simplify the market pricing activity, i.e., to assure that the selected manufacturers and models could be priced nationwide, allowing regional price comparisons. More than one appliance type could be priced in one contact; and numerous options were available from each manufacturer, thus permitting "model pairing" and option identification and pricing.

The basic obstacle in establishing the data base was the sales orientation of the manufacturers brochures. The quality and quantity of generic, technical information presented in this literature was so varied that comparisons of technical specifications between manufacturers are almost impossible, and comparison between the models of one manufacturer is extremely difficult. For example, one manufacturer would state that a particular model is "insulated," and another manufacturer would claim "extra insulation." Comparison of the insulation attributes of these two products is difficult. Also, the manufacturer who claims that the one model has "extra insulation" may also have another model that is "insulated." It is difficult to determine the amount of insulation in either of these two models.

The next step in compiling the market pricing data base was selecting the appliance attributes/options to be identified. Generally, the attributes were chosen for their energy impact or price.

The final task of structuring the data base was the selection of appliance models from each of the chosen manufacturers. This process was repeated for each appliance separately. There was a deliberate attempt to identify "pairs" of appliances, i.e., two appliances alike in every way except for one feature. For each model of each appliance type, the attributes/options were tabulated on a large matrix.

An attempt was made to identify "pairs" of appliances in these matrices with only one or two discernible differences. Other criteria considered in selecting the models for market pricing were: representativeness of the manufacturer's models, and uniqueness of energy-related attributes/options. Several of the appliance models that had been selected for market pricing were found to be obsolete during the actual market pricing. This was due to the fact that

some of the manufacturers' catalogues were for the 1977 model year. In these cases, an equivalent current model/model number was substituted for the obsolete one where possible.

The matrices are coded and computerized to enable a more detailed categorization of the appliance options and pricing data. During the coding process, several of the appliance attributes/ options which had been previously identified in the matrices were deleted because of lack of information on the models, or consistency in the type of information gathered from the manufacturers' catalogues.

3.5 GEOGRAPHIC COVERAGE

The market price data were collected to reflect national prices. As a result, the sample of prices collected were obtained from four widely separated geographical regions. Prices were collected from the western, eastern, north central and south central regions of the United States. The regional prices were collected from Los Angeles, New York City, Chicago, and Houston.

It should be noted that the geographic dispersion reflected in the sample was intended for determining national market prices. It was not intended that regional prices be developed or that market price differentials be measured among the various national regions.

It should also be noted that the sampled regions consist of metropolitan areas. The prices were collected primarily from urban and suburban retailers. This was necessary because by far the larger portion of appliance retail sales are made at suburban and urban locations.

The number of laundry appliance prices that were collected from each region are presented below in the descriptive statistics.

3.6 TYPES OF RETAIL OUTLETS

The sample for market pricing purposes was devised to include each basic type of retail outlet. The objective was to be comprehensive in the sample, accounting for all the types of retail sales being made. The types of retailers included:

- Appliance stores
- Discount stores
- Department stores
- Furniture stores.

A discussion of retailer mark-ups appears below in Section 3.10.

3.7 STATISTICAL METHODOLOGY

The objective of the market price analysis is to estimate the cost of energy saving design options for clothes-washers and clothes-dryers to the consumer on the retail market. For each model selected for this analysis features which may have effects on market prices are identified. For clothes-washers, the information items sought are:

- City of retail establishment
- Type of store
- Manufacturer
- Model number
- Market price
- Loading type (front or top)
- Capacity
- Mechanism of water level controlling
- Spray rinse cycle available
- Deep rinse cycle available
- Softener dispenser available

- Liquid bleach dispenser available
- Number of wash/rinse temperature combinations available
- Number of cycles available
- Control type (dial, push-button or electronic)
- Number of water speeds available
- Type of filter system available
- Mechanism for setting water fill level
- Sud-saver option available
- Maximum cycle time
- Number of speeds available
- Horsepower rating

For clothes-dryers, the information items sought are:

- City
- Type of store
- Manufacturer
- Model number
- Market price
- Fuel type (gas or electric)
- Capacity
- Number of temperature and cycle selections available
- No heat dry option available
- Maximum timed dry cycle length
- Automatic dry option available
- End signal available
- Horsepower rating of motor
- Current rating
- Voltage rating
- Heater wattage rating (for electric)
- Heater Btu rating (for gas)
- Air flow rate
- Automatic dry sensor mechanism (if any)

- Ignition method (for gas)
- Drum finish.

Frequency distributions of the data by city, manufacturer, store type and price are computed. An attempt was made to identify the effects that numerous design options and features have on the market price by using the analysis of variance and covariance (as documented in the air conditioner report). However, due to the large amount of missing data and the way that the design options are matched, many of the effects cannot be determined or isolated. Therefore the analysis of variance cannot be used to produce reliable results.

A paired-model approach is used. In this approach, models are paired according to the principal price influencing features, so that between the pair, all major features are identical except for one energy saving design option. The effect of this option on the market price can then be estimated from these pairs. Details of the results of the analysis are given in Section 3.8 and the summary of these results can be found in Section 3.3.

3.8 RESULTS OF THE MARKET PRICING ANALYSIS

The computer printed bar charts and tabulations appearing in the following figures are descriptive of the results of the market price data collection activity for clothes washers.

Figure 3-1 presents the frequency distribution according to city. Figure 3-2 presents the frequency distribution according to manufacturer. Figure 3-3 presents the frequency distribution according to store type. Figure 3-4 presents the frequency distribution according to price.

The computer printed bar charts and tabulations appearing in the following figures describe the results of the market price data collection activity for clothes dryers.

11/15/78 FILE = CW CREATED 11/15/78 PAGE 2

CITY

CODE

1. ********** (59)
NEW YORK

2. ********** (136)
CHICAGO

3. ********** (113)
HOUSTON

4. ********** (41)
LOS ANGELES

0 40 80 120 160 200
FREQUENCY

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NEW YORK	1.	99	25.4	25.4	25.4
CHICAGO	2.	136	35.0	35.0	60.4
HOUSTON	3.	113	29.0	29.0	89.5
LOS ANGELES	4.	41	10.5	10.5	100.0
	TOTAL	389	100.0	100.0	

Figure 3-1. CLOTHES WASHERS — FREQUENCY DISTRIBUTION OF CITY DATA

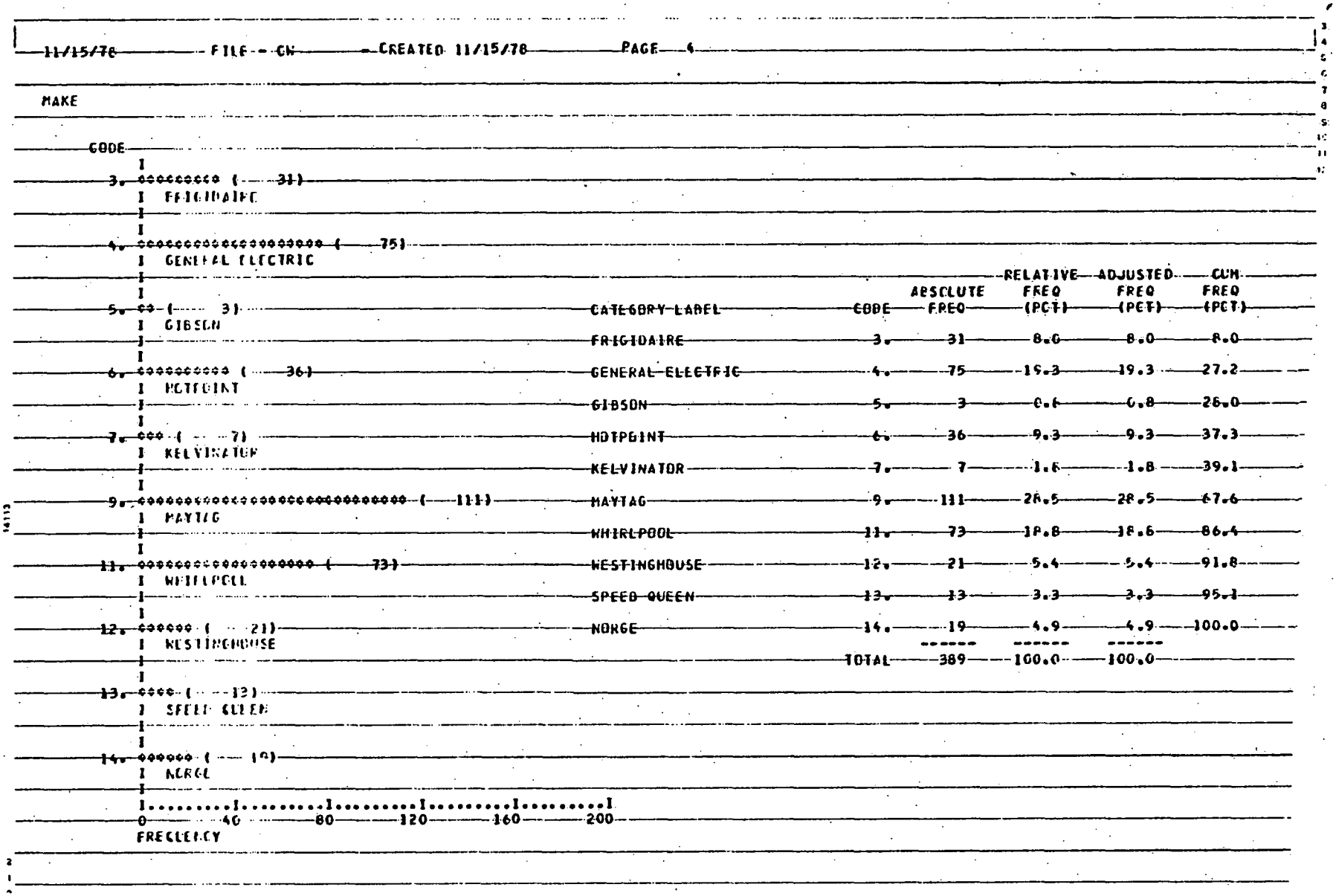
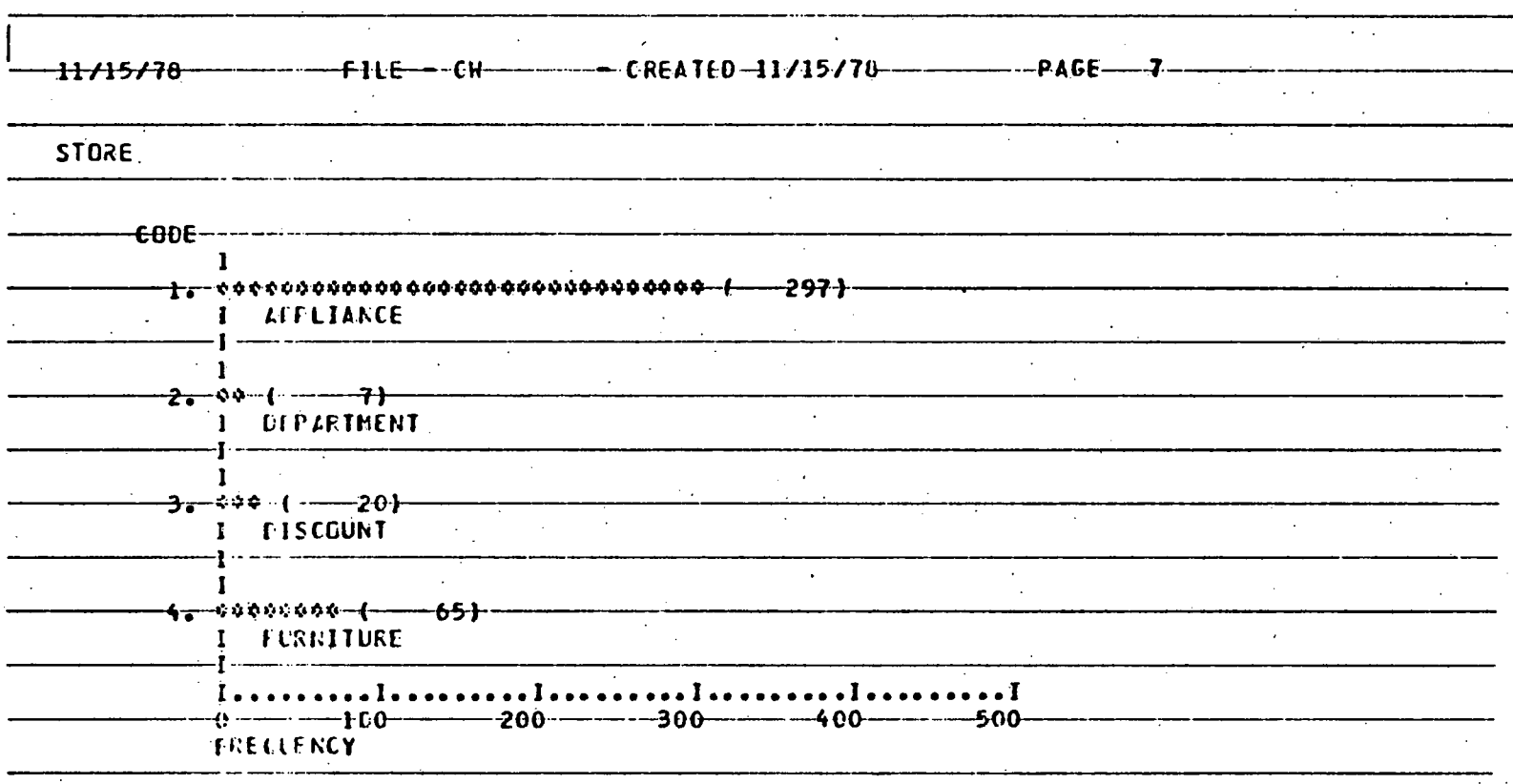
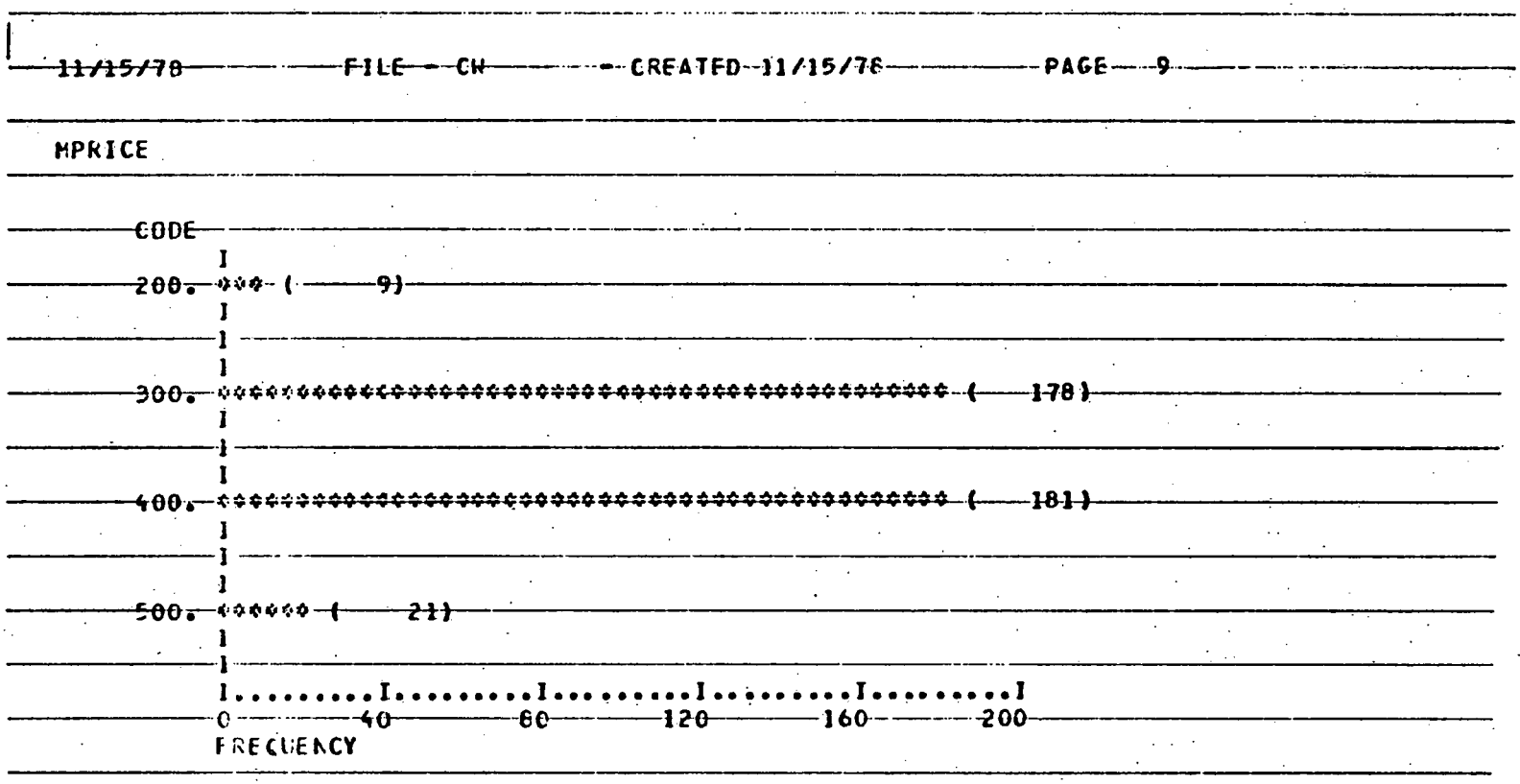


Figure 3-2. CLOTHES WASHER — FREQUENCY DISTRIBUTION OF MANUFACTURER DATA



CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
APPLIANCE	1.	297	76.3	76.3	76.3
DEPARTMENT	2.	7	1.8	1.8	78.1
DISCOUNT	3.	20	5.1	5.1	83.3
FURNITURE	4.	65	16.7	16.7	100.0
	TOTAL	389	100.0	100.0	

Figure 3-3. CLOTHES WASHER — FREQUENCY DISTRIBUTION OF STORE-TYPE DATA



CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
	200.	9	2.3	2.3	2.3
	300.	178	45.8	45.8	48.1
	400.	181	46.5	46.5	94.6
	500.	21	5.4	5.4	100.0
	TOTAL	389	100.0	100.0	

Figure 3-4. CLOTHES WASHER — FREQUENCY DISTRIBUTION OF PRICE DATA

Figure 3-5 presents the frequency distribution according to city. Figure 3-6 presents the frequency distribution according to manufacturer. Figure 3-7 presents the frequency distribution according to store type, and Figure 3-8 presents the frequency distribution according to price.

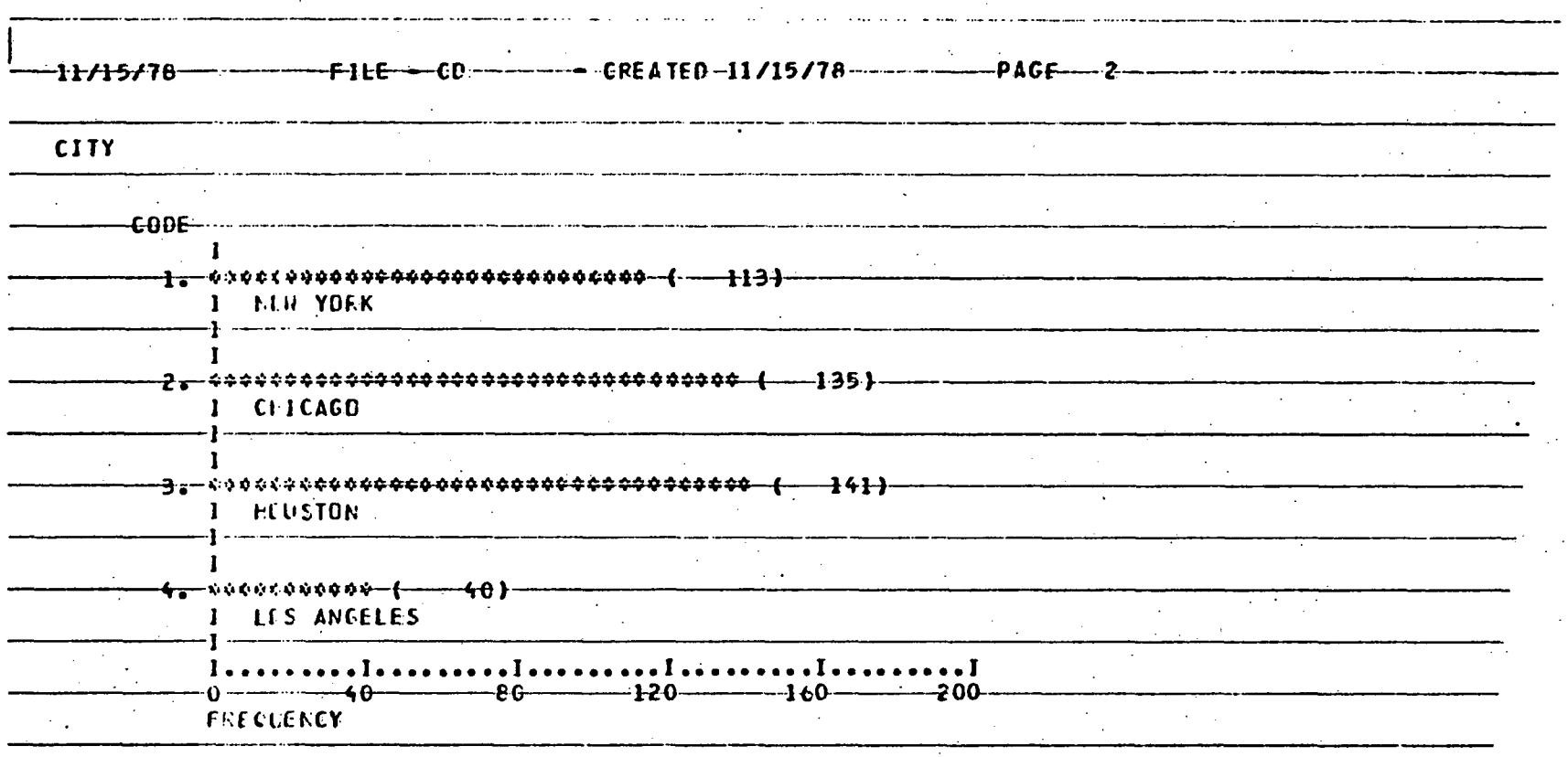
An average price for each model covered in this data base is developed. All models of each manufacturer are examined to produce sets of models with similar features and characteristics. Each set of models is then examined to produce pairs where the principal difference between the two models in a pair is one of the subject energy saving features. The difference in the average price of each model in a pair is then assumed to be the price paid by the consumer for the energy saving feature or option.

Tables 3-2 and 3-3 summarize the market price data used in the final selection of energy saving option pairs. Excluded from this data base are all models and prices which could not be paired to another model due to some unique design characteristic. This information shows that 36 and 17 percent of the price data collected for clothes washers and clothes dryers, respectively, is used in developing incremental prices for energy saving design options.

The results of this analysis of pairs have already been presented in Section 3.3 of this report.

3.9 TRANSPORTATION COSTS

Market prices are comprised basically of manufacturing and distribution costs. Transportation costs are one element of the distribution cost. It does not, however, constitute a significant portion of the distribution costs. For most household appliances, the transportation cost amounts to less than one percent of the market price.



CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NEW YORK	1.	113	26.3	26.3	26.3
CHICAGO	2.	135	31.5	31.5	57.8
HOUSTON	3.	141	32.9	32.9	90.7
LOS ANGELES	4.	40	9.3	9.3	100.0
	TOTAL	429	100.0	100.0	

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Figure 3-5. CLOTHES DRYER — FREQUENCY DISTRIBUTION OF CITY DATA

11/15/78 FILE - CD CREATED 11/15/78 PAGE 4

MAKE

CODE

3. ********** (39)
FRIGIDAIRE

4. ********** (113)
GENERAL ELECTRIC

5. * (1)
GIBSON

6. ********** (40)
HOTPOINT

7. **** (10)
KELVINATOR

9. ********** (79)
MAYTAG

11. ********** (89)
WHIRLPOOL

12. ******* (24)
WESTINGHOUSE

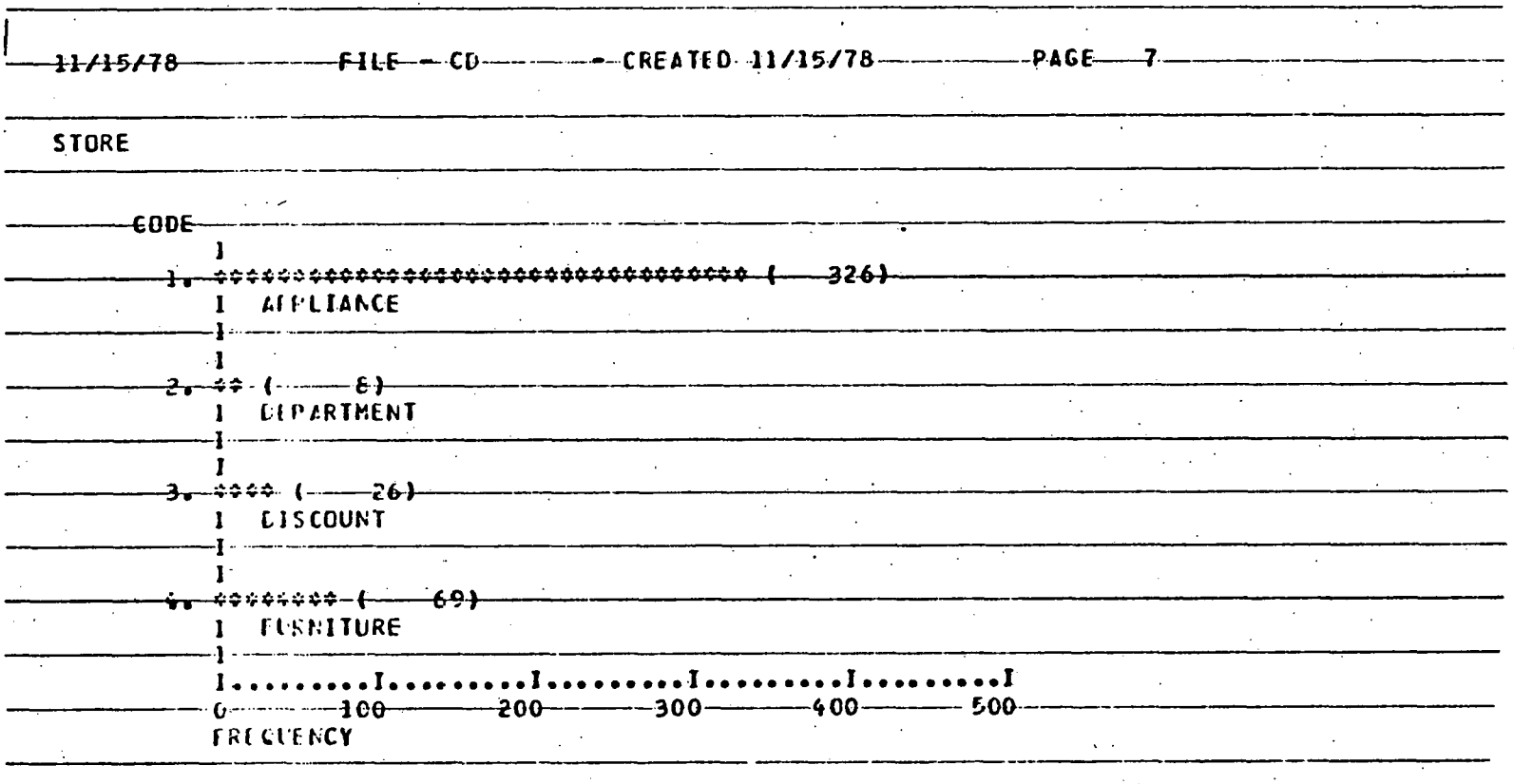
13. **** (11)
SPEED QUEEN

14. ******* (23)
NORGE

0 40 80 120 160 200
FREQUENCY

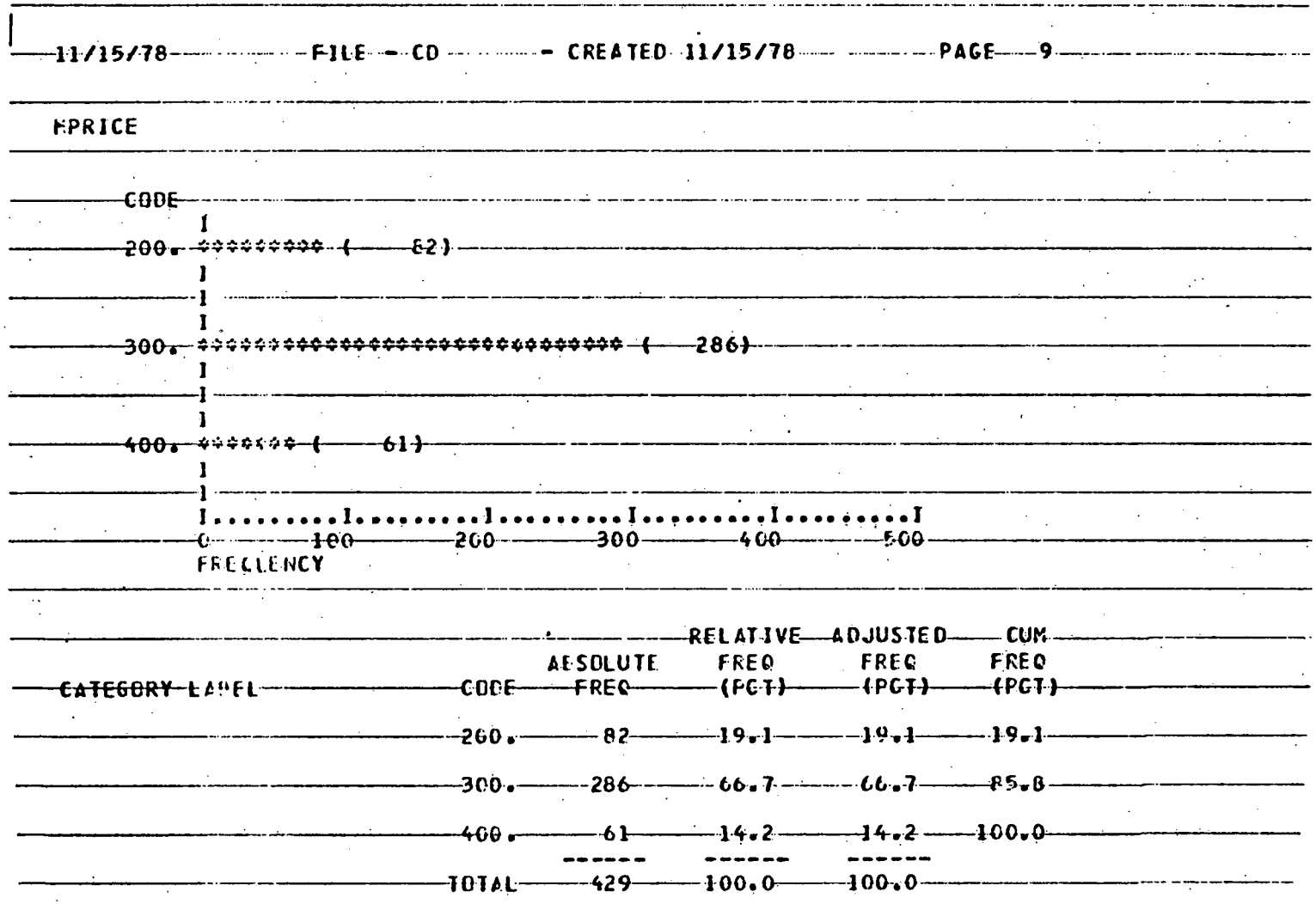
CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
FRIGIDAIRE	3.	39	9.1	9.1	9.1
GENERAL ELECTRIC	4.	113	26.3	26.3	35.4
GIBSON	5.	1	0.2	0.2	35.7
HOTPOINT	6.	40	9.3	9.3	45.0
KELVINATOR	7.	10	2.3	2.3	47.3
MAYTAG	9.	79	18.4	18.4	65.7
WHIRLPOOL	11.	89	20.7	20.7	86.5
WESTINGHOUSE	12.	24	5.6	5.6	92.1
SPEED QUEEN	13.	11	2.6	2.6	94.6
NORGE	14.	23	5.4	5.4	100.0
TOTAL		429	100.0	100.0	

Figure 3-6. CLOTHES DRYER — FREQUENCY DISTRIBUTION OF MANUFACTURERS DATA



CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
APPLIANCE	1.	326	76.0	76.0	76.0
DEPARTMENT	2.	8	1.9	1.9	77.9
DISCOUNT	3.	26	6.1	6.1	83.9
FURNITURE	4.	69	16.1	16.1	100.0
	TOTAL	429	100.0	100.0	

Figure 3-7. CLOTHES DRYER — FREQUENCY DISTRIBUTION OF STORE-TYPE DATA



CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
	200.	82	19.1	19.1	19.1
	300.	286	66.7	66.7	85.8
	400.	61	14.2	14.2	100.0
	TOTAL	429	100.0	100.0	

Figure 3-8. CLOTHES DRYER — FREQUENCY DISTRIBUTION OF PRICE DATA

Table 3-2. MARKET PRICING DATA USED IN THE SELECTION OF OPTION PAIRS FOR CLOTHES WASHERS

Manufacturer	Number of Models	Number of Prices	Number of Option Pairs Found	Number of Prices Used
GE	4	75	0	0
Hotpoint	4	35	1	27
Maytag	5	111	1	62
Whirlpool	5	73	0	0
Westinghouse	4	21	1	21
Speed Queen	3	13	1	13
Norge	2	9	0	0
Total	27	337		123

Table 3-3. MARKET PRICING DATA USED IN THE SELECTION OF OPTION PAIRS FOR CLOTHES DRYERS

Manufacturer	Number of Models	Number of Prices	Number of Option Pairs Found	Number of Prices Used
GE	6	113	0	0
Hotpoint	4	38	0	0
Maytag	4	76	1	57
Whirlpool	5	74	0	0
Westinghouse	4	19	0	0
Norge	3	14	0	0
Total	26	334		57

It should be noted, however, that identifiable transportation costs are only those that are incurred for shipments from manufacturers to retailers or to local distributors. There can be additional shipping costs incurred by retailers and distributors that are difficult to determine. The larger retailers can have centralized receiving and warehouse facilities, requiring additional transportation to retail outlets. However, because retailers and distributor shipping is mostly local, the associated costs should be less than those incurred in manufacturer shipping, and therefore, would be even less significant relative to the market price.

The data that are available on transportation costs frequently do not separately identify each product covered in this report. Inasmuch as unit values are approximately the same, and average hauling distances for all types of appliances are very close, data for other appliances can be regarded as valid for laundry appliances.

The major portion of appliance shipments are carried by railroads. Table 3-4 presents the transportation modal distribution of household appliance shipments.

The major determinants of transportation cost are the freight rates that are in effect. Freight rates are set by the Interstate

Table 3-4. PERCENT DISTRIBUTION OF APPLIANCE SHIPMENTS BY TRANSPORTATION MODE

	Rail	Common Motor Carrier	Private Trucks	Other
Ranges	62%	30%	6%	2%
Refrigerators/ Freezers	72	27	1	-
Washers & Dryers	61	36	3	-
Other Appliances	58	35	6	1

Source: *1972 Census of Transportation* (Part 3), Bureau of Census, Washington, D. C.

Commerce Commission. Many considerations enter into the setting of freight rates, such as value of service, the cost of providing transportation, and intermodal competition. Approximately 300,000 approved freight rates are on file with the Interstate Commerce Commission, covering particular goods, and specific points of origin and destination. As a result of this voluminous detail, it is difficult to develop national aggregates on rates which apply to certain products, such as particular household appliances.

Waybill compilations are available for rail shipments, from which useful cost data can be derived. Similar data are not available for motor carriers. As national averages, the waybill statistics for rail shipments indicate the shipping costs shown in Table 3-5.

Table 3-5. RAIL SHIPPING COSTS PER TON/MILE

Appliance	Cents per Ton/Mile
Household Laundry Equipment	8.84
Refrigerators and Freezers	7.34
Other Household Appliances	6.24

Source: *Carload Waybill Statistics*, 1976, U. S. Department of Transportation, Washington, D. C.

The unit shipping costs, presented in Table 3-5 above, together with data on shipping distances, can provide appliance shipping costs. Data on shipping distances are available for different commodities. Data on shipping distances for different commodities are collected periodically by survey. The results of the most recent survey are shown in Table 3-6 below.

Table 3-6. PERCENTAGE DISTRIBUTION OF APPLIANCE SHIPMENTS ACCORDING TO MILES SHIPPED

Appliance	Miles Shipped						
	Less than 100	100-199	200-299	300-400	500-999	1000-1499	Over 1500
Ranges and Ovens	12%	6%	8%	26%	34%	9%	5%
Laundry Equipment	14	11	9	29	23	9	5
Refrigerators and Freezers	5	9	13	29	32	8	5
Other Appliances	9	8	10	26	31	8	7

Source: *1972 Census of Transportation* (Part 3), U. S. Summary, U. S. Bureau of Census, Washington, D. C.

From the data presented in Table 3-6 above, it is possible to make approximations of average hauling distances. Such approximations appear in Table 3-7 below.

Table 3-7. APPROXIMATE AVERAGE HAULING DISTANCES

Appliances	Miles
Ranges	600
Refrigerators and Freezers	600
Laundry Equipment	550
Other Appliances	650

In addition to shipping costs per ton/mile and the average hauling distances, appliance shipping weights are needed to calculate average unit shipping costs. Table 3-8 below was developed from a sample of appliance shipping weights.

Table 3-8. TYPICAL APPLIANCE SHIPPING WEIGHTS (IN POUNDS)

Appliances	Pounds
Ranges	250
Refrigerators and Freezers	300
Laundry Equipment	175
Dishwashers	120
Window Air Conditioners	150
Dehumidifiers	60

With the data presented thus far, it is possible to estimate the average shipping costs of appliances. The following formula can be used for the calculation:

$$S = \frac{C}{2000} W(D)$$

where: S = Shipping cost of appliances
C = Cost per ton/mile
W = Average weight of appliances in pounds
D = Average distance transported in miles.

The results of applying the above formula are shown in Table 3-9.

Table 3-9. UNIT APPLIANCE SHIPPING COSTS

Appliances	Per Unit
Refrigerator	$5.50
Laundry Equipment	4.50
Ranges[1]	4.00
Dishwasher[1,2]	2.50
Window Air Conditioner[1,2]	3.00

[1]Cost per ton/mile of "Other Appliances."
[2]Hauling distance for "Other Appliances."

Table 3-10 below presents unit shipping costs of appliances as the percentages of average market price.

Table 3-10. TRANSPORTATION COST AS PERCENTAGE OF MARKET PRICE

Appliance	Unit Transportation Cost	Average Market Price	% Transportation Cost
Clothes Washers and Dryers	$4.50	$326	1.4%
Ranges	4.00	450	.9
Dishwashers	2.50	387	.6
Room Air Conditioner	3.00	355	.8

3.10 RETAILER MARGINS

Retailer margins constitute an important part of appliance distribution costs. The retailer margin is normally expressed as a percentage of the wholesale price, added on to cover the costs of retailing the merchandise. Retailer margins cover a variety of costs, such as rent on retail floor space, utilities; interest on financing inventories; wages and salaries of sales persons, stock clerks, managers, and warehouse workers; and owners' profits.

Retail margins vary significantly according to type of retail establishment. Table 3-11 below presents gross retail margins as the percentage of final retail price. The difference in retailer margins probable contributes significantly to the difference found in market prices among types of retail stores, which was discussed earlier in the report. Discount stores, which have the lowest gross margins, also have the lowest market prices. Appliance stores, which have the highest gross margins, have the highest market prices.

Table 3-11. RETAILER GROSS MARGINS

Type	Mark-up as Percent of Market Price
Appliance Stores	27.6
Department Stores	22.4
Discount Stores	17.0
Furniture Stores with Sales of:	
$250,000 - 500,000	44.0
500,000 - 1,000,000	32.0
Over 1,000,000	25.0

Source: Collected by various retailer trade associations, including: National Retailer Merchants Association, Mass Retailing Institute, National Home Furnishings Association, and National Appliance Retail Dealers Association. The data were published in *Merchandising,* February 1977.

4. COMPARISON OF INDUSTRIAL ENGINEERING AND MARKET PRICING COST ESTIMATING RESULTS

4.1 GENERAL

This section compares the results of the two cost estimating techniques used in this analysis for selected energy saving options associated with laundry products. Engineering cost estimates are developed in Section 2 for 10 design options for clothes washers and the same number for clothes dryers. The analysis of market price data produced incremental prices for three clothes washer options and one clothes dryer option.

4.2 COST VERSUS PRICE COMPARISON FOR LAUNDRY PRODUCTS

Table 4-1 summarizes the comparable incremental costs and prices for common design options developed from this analysis. It should be noted that the engineering estimates are developed for a specific design feature and that the market price data may include appliance features or characteristics which are not specified or visible in the data base.

TABLE 4-1. COST VS. PRICE COMPARISONS FOR LAUNDRY PRODUCTS

Appliance	Design Option	Incremental Cost ($)	Incremental Cost ($)
Clothes Washer	• Recycle Wash Water	$9.46	$33.00
	• Improve Fill Control	5.36	22.00
	• Front Loading Configuration	21.15	16.95
Clothes Dryer	• Improve Dryness Sensor	7.21	29.14

The results displayed for front loading clothes washing machines do not appear to be consistent with the cost/price relationships for the other options. This disparity is probably due to the fact that front loading is not a design option. It is a major change in the machine configuration and should be considered as a separate product class. This situation serves to invalidate the engineering estimate since the cost to manufacture a totally different washing machine is not within the scope of this analysis. The market price results for front loaders may also be lower than normal. This type of machine, which is only made by one manufacturer, is not the popular configuration. It is conceivable that the pricing structure for front loaders contains less mark-up to maintain an acceptable sales volume.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

This section presents a narrative appraisal of this analysis and the results obtained from its accomplishment. It also contains several suggested areas of refinement which should be addressed in subsequent research activities of this subject.

5.2 CONCLUSIONS REGARDING DESIGN OPTIONS

The design option approach to estimating incremental costs of energy saving features is a viable concept for clothes washers and dryers. This viability is based upon the relative independence of the various components of these appliances. Unlike air conditioners and dehumidifiers, the design of laundry products is more compatible to the modular approach to achieving higher energy efficiency.

5.3 CONCLUSIONS REGARDING INDUSTRIAL ENGINEER COST ESTIMATES

There are several trade-offs between the labor and capital expense which may be realized through the introduction of a design modification. These trade-offs may depend upon local labor conditions, existing design practices, management philosophy, and the competitive position of each manufacturer. Further, there is no guarantee that the appliance industry will use any of the options considered in this analysis to meet minimum energy efficiency standards. It should be noted, however, that these results probably bracket the actual costs that would be incurred from the establishment of national energy standards.

5.4 CONCLUSIONS REGARDING THE MARKET PRICING ANALYSIS

Retail price data is relatively easy to obtain for selected makes and models of laundry produces. A description of all energy related design features for the same models is not, however, readily available from the information provided to the consumer. Therefore, it is not possible to relate the retail price of a product to all of the energy saving design features of that product. The information currently available to the consumer does not contain all of this data. Since this condition cannot be readily circumvented, there are only a few areas in this analysis where the impact of an estimated charge in manufacturers cost for a specific option can be related to a change in the retail price of a product containing the same option.

5.5 AREAS OF ANALYSIS NEEDING FURTHER INVESTIGATION

- The industrial engineering cost estimates can be refined through additional analysis and expansion of the already existing and extensive data base. The accuracy of these cost estimates and the knowledge of their impact upon all manufacturers are crucial to the support of a given level of regulation. This task should be expanded as follows:

  - To include the projected cost of implementing the engineering options, based upon knowledge of the current production techniques and specific practices of each product manufacturer.

  - To include projected costs to the consumer, based upon a sampling of the full spectrum of manufacturers of a product class.

  - To include the development of an optimization algorithm to choose the appropriate mix of engineering options to achieve given regulatory goals.

- The collection of market prices and the investigation of sales outlets for appliances have indicated that the following refinements should be made:

  - Expansion of the outlets investigated to include builders' suppliers to capture a much more objectively priced market than the retail replacement market, as well as to provide coverage of a major market segment.

  - Expansion of the product specification data base to provide a more comprehensive technical description of models for pricing correlations of energy related options and non-energy related features.